

American National Standard

for information systems –
serial recorded magnetic tape cartridge
for information interchange –
4 and 9 track, 0.250 inch (6.30 mm),
8000 bpi (315 bpm) streaming mode,
group code recording



american national standards institute, inc.
1430 broadway, new york, new york 10018

ANSI X3.136-1986

R
620.1
Am356
ANSI
X3.136
1986

**American National Standard
for Information Systems –**

**Serial Recorded Magnetic Tape Cartridge
for Information Interchange –
4 and 9 Track, 0.250 inch (6.30 mm),
8000 bpi (315 bpm) Streaming Mode,
Group Code Recording**

Secretariat

Computer and Business Equipment Manufacturers Association

Approved February 28, 1986

American National Standards Institute, Inc

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of approval. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

**American National Standards Institute
1430 Broadway, New York, New York 10018**

Copyright © 1986 by American National Standards Institute, Inc
All rights reserved.

No part of this publication may be reproduced in any form,
in an electronic retrieval system or otherwise, without
the prior written permission of the publisher.

Printed in the United States of America

A1M686/7

Foreword (This Foreword is not part of American National Standard X3.136-1986.)

This standard presents the minimum requirements for the organization and location of magnetically encoded data on a 0.250-inch (6.30-mm)-wide magnetic tape to allow parties that comply with these requirements to reliably interchange information. The standard applies to 4- and 9-track, 8000-bpi (315-bpmm), serial, group-coded information using tape drives that operate in the streaming mode.

The advantage of using the format described in this standard is that it provides far greater data capacities and higher data transfer rates than are provided by the existing formats. For example, the 9-track format allows 45 megabytes of formatted data to be recorded on a cartridge meeting the requirements of American National Standard for Information Processing – Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 inch (6.30 mm), 1600 bpi (63 bpmm), phase encoded, ANSI X3.55-1982, while previous stop/start formats allowed a maximum of 18 megabytes.

This standard was developed by Technical Committee X3B5 on Digital Magnetic Tape. This group consists of experienced and qualified specialists on the recording of digital information on magnetic tape. In the development of this standard, careful consideration was given to current practices, existing equipment and supplies, achieving the broadest possible acceptance, and providing a basis for a future improvement in the use of the medium.

The impetus to develop this standard was the sudden increase in requirements for tape backup systems in the early 1980's. The demand was fueled by the great increase in the use of small, inexpensive, fixed media rigid disk drives for computer systems. The industry provided *de facto* standard products that were to become the basis for the cartridges described in this American National Standard.

Suggestions for improvement of this standard will be welcome. They should be sent to the Computer and Business Equipment Manufacturers Association, 311 First Street, NW, Washington, DC 20011.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Information Processing Systems, X3. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

Edward Lohse, Chair
Richard Gibson, Vice-Chair
Catherine A. Kachurik, Administrative Secretary

<i>Organization Represented</i>	<i>Name of Representative</i>
American Express	D. L. Seigal Lucille Durfee (Alt)
American Library Association	Paul Peters
American Nuclear Society	Geraldine C. Main D. R. Vondy (Alt)
AMP Incorporated	Patrick E. Lannan Edward Kelly (Alt)
Association for Computing Machinery	Kenneth Magel Jon A. Meads (Alt)
Association of the Institute for Certification of Computer Professionals	Thomas M. Kurihara
AT&T Communications	Henry L. Marchese Richard Gibson (Alt)
AT&T Information Systems	Herbert V. Bertine Paul D. Bartoli (Alt)
Burroughs Corporation	Stanley Fenner
Control Data Corporation	Charles E. Cooper Keith Lucke (Alt)

<i>Organization Represented</i>	<i>Name of Representative</i>
Cooperating Users of Burroughs Equipment	Thomas Easterday Donald Miller (Alt)
Data General Corporation	John Pilat Lyman Chapin (Alt)
Data Processing Management Association	Christian G. Meyer
Digital Equipment Computer Users Society	William Hancock Charles Mustain (Alt)
Digital Equipment Corporation	Gary S. Robinson Delbert L. Shoemaker (Alt)
Eastman Kodak	Charleton C. Bard Gary Haines (Alt)
General Electric Company	William R. Kruesi Richard W. Signor (Alt)
General Services Administration	William C. Rinehuls Larry L. Jackson (Alt)
GUIDE International	Frank Kirshenbaum Thomas F. O'Leary, Jr (Alt)
Harris Corporation	Walter G. Fredrickson Rajiv Sinha (Alt)
Hewlett-Packard	Donald C. Loughry
Honeywell Information Systems	Thomas J. McNamara David M. Taylor (Alt)
IBM Corporation	Mary Anne Gray Robert H. Follett (Alt)
IEEE Computer Society	Sava I. Sherr Thomas M. Kurihara (Alt)
Lawrence Berkeley Laboratory	Thomas A. Varetoni (Alt) David F. Stevens
Moore Business Forms	John S. Colonias (Alt)
National Bureau of Standards	Delmer H. Oddy Robert E. Rountree
National Communications System	James Moulton (Alt) Marshall L. Cain
NCR Corporation	George W. White (Alt) Thomas W. Kern
Perkin-Elmer Corporation	A. Raymond Daniels (Alt) Christopher Beling
Prime Computer, Inc	Russ Lombardo (Alt) Joseph Schmidt
Railine Corporation	John McHugh (Alt) R. A. Petrash
Recognition Technology Users Association	Herbert F. Schantz G. W. Wetzel (Alt)
SHARE, Inc	Thomas B. Steel Robert A. Rannie (Alt)
Sperry Corporation	Marvin W. Bass Jean G. Smith (Alt)
Texas Instruments, Inc	Presley Smith Richard F. Trow, Jr (Alt)
3M Company	J. Wade Van Valkenburg R. C. Smith (Alt)
Travelers Insurance Companies, Inc.	Joseph T. Brophy
U.S. Department of Defense	Fred Virtue Belkis Leong-Hong (Alt)
VIM.	Chris Tanner Madeline Sparks (Alt)
VISA International	Jean T. McKenna Susan Crawford (Alt)
Wang Laboratories, Inc.	Marsha Hayek Joseph St. Amand (Alt)
Xerox Corporation	John L. Wheeler

Technical Committee X3B5 on Digital Magnetic Tape, which was responsible for the development of this standard, had the following members:

Richard Steinbrenner, Chair

David M. Allen	Kenji Ishikawa	Maritza Robbennolt	Shuichi Homma (Alt)
Bruce Anderson	Kyriacos Joannou	Howard Robinson	Marlin Klumpp (Alt)
David Barrett	Charles Klueber	Arnold J. Roccati	Ken Lovern (Alt)
Mark Beisecker	K. Kobayashi	John Rooks	Jack Marion (Alt)
L. Britchkow	Noel Leifer	Dave Sheppard	Robert McWade (Alt)
Mike Bolt	Richard Lewis	Robert E. Smiley	Eddie Morioka (Alt)
Chuck J. Cassidy	Demetrios Lignos	David Vogensen	Jack Niebell (Alt)
Sam Cheatham	Donald F. Lynch	Bob Abe (Alt)	Normand Precourt (Alt)
James U. Chestnutt	Michael Marchese	Arthur R. Anderson (Alt)	Wayne Prokosch (Alt)
Al Ching	Kazuyuki Masukane	Robert B. Anthony (Alt)	Clyde Roberts (Alt)
Dean L. Christensen	Stephen McQuiston	Steve Banas (Alt)	Robert Rossi (Alt)
C. R. Claber	William P. Mealey	Tony Barbarino (Alt)	Gerhard Rotter (Alt)
Donald Clapp	Tony Merdian	Tom Bendon (Alt)	Thomas Scannell (Alt)
Carl Cox	William R. Miller	David Berry (Alt)	Guenter Schneider (Alt)
Hoyle Curtis	Gary D. Moeller	Rick Cecil (Alt)	Ron Sutton (Alt)
John Delmar	G. Nelson	Mauro Cioletti (Alt)	Richard Thornley (Alt)
Michael Deese	Nick Ogoshi	Clyde Cornwell (Alt)	Barney Thornton (Alt)
M. Difede	Gene Peacher	Kenneth H. Dawson (Alt)	James V. Tierney (Alt)
Donald Elderson	John B. Peters	Kenji Eigner (Alt)	D. F. Tinari (Alt)
Art Evans	Keith Pollock	H. Findeisen (Alt)	Cloys Tolbert (Alt)
Ernest L. Fogle	Joseph P. Pomian	John Fleming (Alt)	Daniel J. Wasser (Alt)
D. Hekimi	Don Rasmussen	Sam George (Alt)	Kirk Wilson (Alt)
Harry Hinz	Jerry Resnikoff	Dana Grubb (Alt)	Andrew Wrobel (Alt)
Michael Hogan	Bob Richmond	H. O. Hemdal (Alt)	Joseph S. Zajackowski (Alt)

Contents	SECTION	PAGE
	1. Scope and Purpose	7
	1.1 Scope	7
	1.2 Purpose	7
	2. Referenced and Related Standards	8
	2.1 American National Standards.	8
	2.2 Other Standards	8
	2.3 Related American National Standard.	8
	3. Definitions.	8
	4. Recording	11
	4.1 Method	11
	4.2 Code.	11
	4.3 Density of Recording.	11
	4.4 Measurement of Signal Amplitude	12
	4.5 Signal Amplitude.	12
	4.6 Erasure	12
	4.7 Azimuth	12

SECTION	PAGE
5. Tracks	13
5.1 Number of Tracks	13
5.2 Use of Tracks	13
5.3 Reference Plane	13
5.4 Track Centerline Locations	15
5.5 Track Width	15
6. Recorded Block	15
6.1 Preamble	15
6.2 Data Block Marker	15
6.3 Data Block	15
6.4 Block Address	15
6.5 Cyclical Redundancy Check	16
6.6 Postamble	16
7. File Mark Block	16
8. Control Block	16
8.1 Data Field	16
8.2 Use of Control Blocks	16
9. Rewritten Blocks	17
9.1 Error	17
9.2 Streaming Termination	17
9.3 Forced Streaming	17
9.4 End of Recorded Data	17
Table 1 Translation Table for Data Nibbles and GCR Nibbles	12
Figures	
Figure 1 Tape Position Holes	9
Figure 2 Possible Cartridge Configuration	10
Figure 3 Flux Transition Timing	13
Figure 4 Bit Pattern	13
Figure 5 Position of Track Centerlines	14
Figure 6 Recorded Block Format	14
Figure 7 Block Address	15
Figure 8 Sequences of Rewritten Blocks	18
Figure 9 Streaming Termination	19
Figure 10 Forced Streaming	19

American National Standard for Information Systems –

Serial Recorded Magnetic Tape Cartridge for Information Interchange – 4 and 9 Track, 0.250 inch (6.30 mm), 8000 bpi (315 bpmm) Streaming Mode, Group Code Recording

1. Scope and Purpose

1.1 Scope. This American National Standard is intended to provide a format and recording standard for an 8000-bpi (315-bpmm) streaming 0.250-inch (6.3-mm)-wide, 4- and 9-track, magnetic tape in a cartridge to be used for information interchange between information processing systems, communication systems, and associated equipment utilizing a standard code for information interchange, as agreed upon by the interchange parties. This standard specifies the requirements for the 4-track and 9-track formats. The two formats shall not exist on the same cartridge. This standard refers solely to recording on the 0.250-inch (6.30-mm) magnetic tape cartridge and complements American National Standard for Information Systems – Unrecorded Magnetic Tape Cartridge for Information Interchange – 0.250 inch (6.30 mm), 6400–10 000 fpi (252–394 ftpmm), ANSI X3.127.¹ In that related standard, the following sections are dealt with in detail: general requirements, definition, tape and cartridge, physical and magnetic requirements, speed requirements, and write enable feature. Compliance with ANSI X3.127 is a requirement for information interchange. A labeling standard for tape cartridges used in the streaming mode is being investigated. The availability of such a labeling standard will provide for full data interchange between data processing systems.

¹ This standard is currently under development. Contact the Secretariat for the most recent information on the status and availability of this standard.

CAUTION NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights.

By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in communication therewith. The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from the publisher.

No representation or warranty is made or implied that this is the only license that may be required to avoid infringement in the use of this standard.

1.2 Purpose

1.2.1 This standard defines the requirements and supporting test methods necessary to ensure interchange at acceptable performance levels. It is distinct from a specification in that it delineates a minimum of restrictions consistent with compatibility in interchange transactions.

1.2.2 The performance levels contained in this standard represent the minimum acceptable levels of performance for interchange purposes. They therefore represent the performance levels that the interchanged items should meet or surpass during their useful life and thus define end-of-life criteria for interchange purposes. The performance levels in this standard are not intended to be employed as substitutes for purchase specifications.

1.2.3 Wherever feasible, quantitative performance levels that shall be met or exceeded in order to comply with this standard are given. In all cases, including those in which quantitative limits for requirements falling within the scope of this standard are not stated but are left to agreement between interchange parties,

standard test methods and measurement procedures shall be used to determine such limits.

1.2.4 U.S. engineering units are the original dimensions in this standard. Conversions of toleranced dimensions from customary U.S. engineering units (similar to British Imperial Units) to SI units have been incorporated in this standard according to Method A as described in American National Standard Metric Practice, ANSI/IEEE 268-1982, and in International Standard for Toleranced Dimensions — Conversion from Inches into Millimetres and Vice-Versa, ISO 370-1975. Method A, as described in ANSI/IEEE 268-1982, should be used for economy unless requirements for absolute assurance of fit justifies use of Method B. In the national standards of ISO member nations, additional rounding may be done to produce “preferred” values. These values should lie within or close to the original tolerance ranges.

1.2.5 Except as indicated in 1.2.3, interchange parties complying with the applicable standards should be able to achieve compatibility without need for additional exchange of technical information.

2. Referenced and Related Standards

2.1 American National Standards. This standard is intended to be used in conjunction with the following American National Standards. When these standards are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

ANSI X3.4-1986, Information Systems — Coded Character Sets — 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)

ANSI X3.54-1986, Information Systems — Recorded Magnetic Tape for Information Interchange (6250 CPI, Group-Coded Recording)

ANSI/IEEE 268-1982, Metric Practice

2.2 Other Standards. This standard is also intended to be used in conjunction with International Standard for Toleranced Dimensions — Conversion from Inches into Millimetres and Vice Versa, ISO 370-1975.²

2.3 Related American National Standard

ANSI X3.127, Information Interchange — Unrecorded Magnetic Tape Cartridge for Information Interchange — 0.250 inch (6.30 mm), 6400–10 000 fpi (252–394 ftpmm)¹

² Available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

3. Definitions

3.1 Azimuth. The angular deviation, in minutes of arc, of the mean flux transition line from the line normal to the cartridge reference plane.

3.2 Bit. A single digit in the binary number system.

3.3 Bit Cell. A distance along the track between adjacent flux transitions at 10 000 flux transitions per inch (ftpi) (394 flux transitions per millimeter (ftpmm)).

3.4 Block. A group of 512 consecutive bytes transferred as a unit.

3.5 Beginning of Tape (BOT) Marker. The BOT Marker is a set of two holes punched in the tape. There are three sets of holes provided, the innermost of which is used for the purpose of identifying the storage position for the cartridge. The additional sets of holes are used to ensure reliability of detection (see Figure 1).

NOTE: In the storage position, all of the permissible recording area is wound on the supply hub and is protected by at least one layer of tape. Cartridges to be interchanged shall be re-wound to the storage position prior to interchange.

3.6 Byte. A group of 8 data (10 encoded) bits operated on as a unit.

3.7 Magnetic Tape Cartridge. A cartridge containing 0.250-inch (6.30-mm)-wide magnetic tape wound on two coplanar hubs with an internal drive belt to transport the tape between the hubs (see Figure 2).

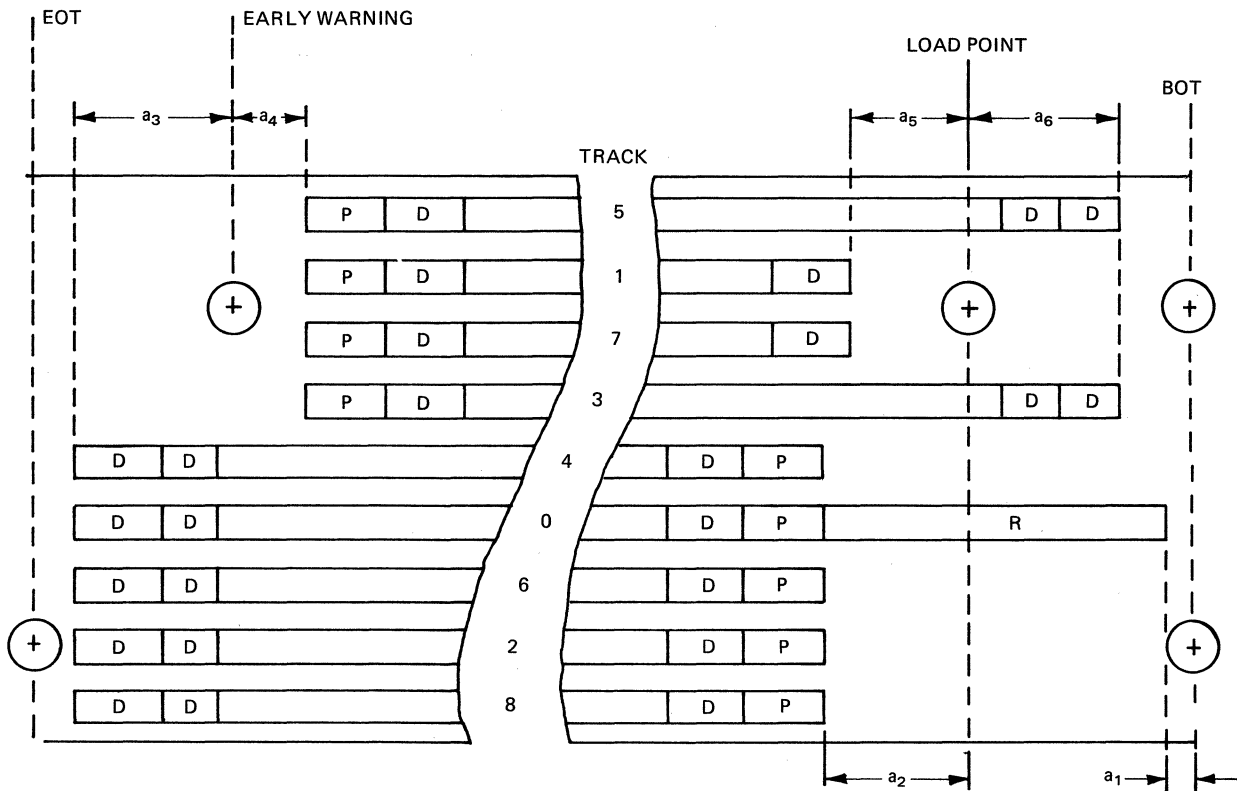
3.8 Cyclic Redundancy Check (CRC). The check that is recorded after the data block and preceding the postamble of each recorded block for the purpose of error detection.

3.9 Data Density. The nominal distribution of recorded information per unit length of track, usually expressed in bits per inch (bpi) or bits per millimeter (bpmm).

3.10 Physical Recording Density. The number of recorded flux transitions per unit length of track, usually expressed in flux transitions per inch (ftpi) or flux transitions per millimeter (ftpmm).

3.11 Early Warning (EW) Marker. The EW Marker is a single hole punched in the tape to indicate the approaching end of the usable recording area in the forward direction (see Figure 1).

3.12 End of Tape (EOT) Marker. Three single holes punched in the tape to ensure reliability of detection. The EOT Marker indicates that the usable recording area has been exceeded and the physical end of tape is approaching (see Figure 2).



NOTE: R = Reference burst; P = Preamble; D = Data or control block.

Dimension	Minimum		Maximum		Description
	(inch)	(mm)	(inch)	(mm)	
a_1	0	0	0	0	BOT to start of track reference burst
a_2	3.0	76.2	4.0	101.6	Load point to end of track reference burst and start of preamble on even tracks
a_3	—	—	36.0	914.4	Early warning to end of data on even tracks
a_4	1.0	25.4	2.0	50.8	Early warning to start of preamble on odd tracks
a_5	0.1	2.5	4.0	101.6	End of data to load point on Tracks 1 and 7
a_6	—	—	27.0	685.8	Load point to end of data on Tracks 3 and 5

Figure 1
Tape Position Holes

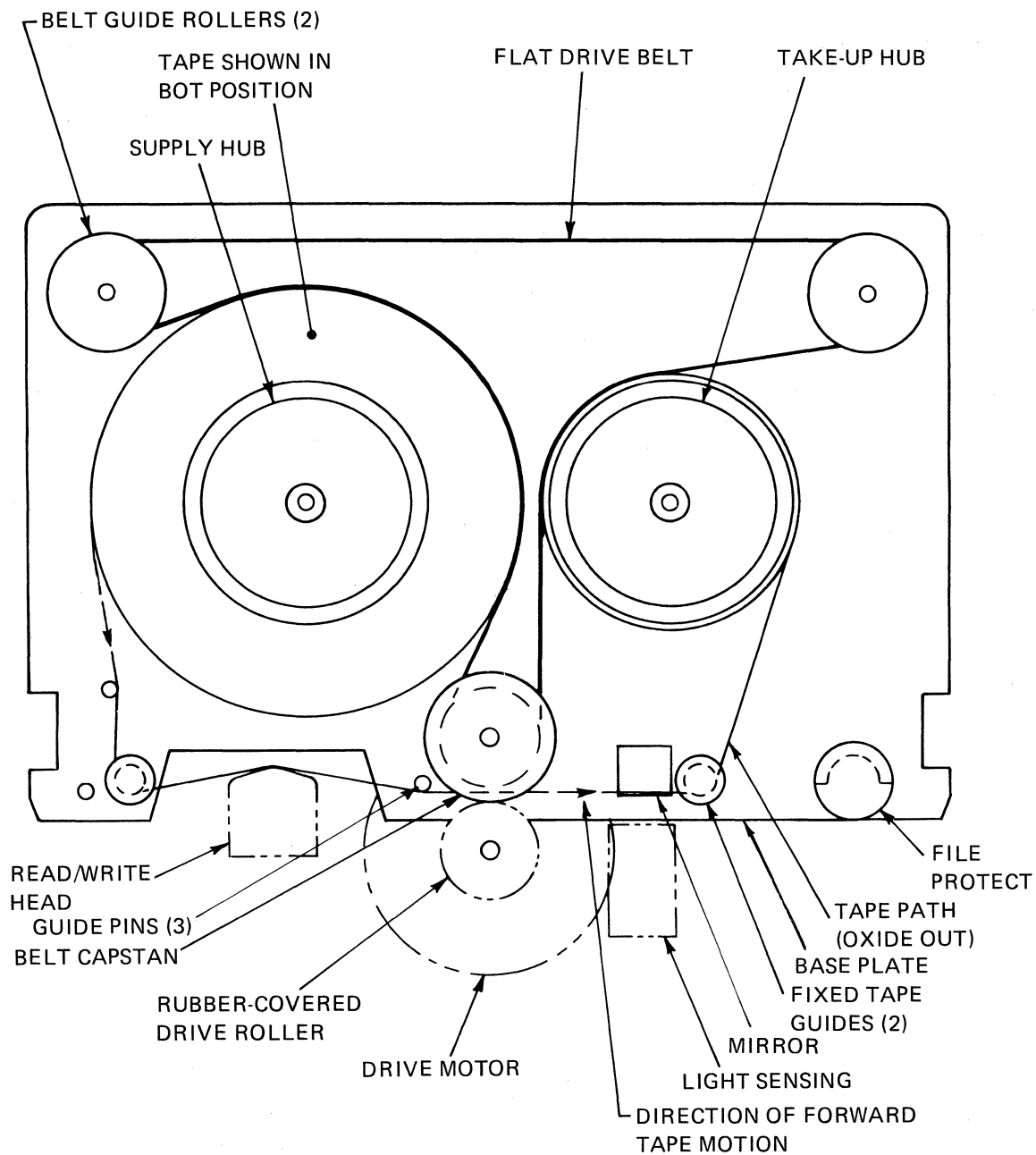


Figure 2
Possible Cartridge Configuration

3.13 Erase. To remove all magnetically recorded information from the tape.

3.14 File Mark. An identification mark following the last block in a file.

3.15 Flux Transition. A point on the magnetic tape that exhibits maximum free space flux density normal to the tape surface.

3.16 Flux Transition Spacing. The distance on the magnetic tape between flux transitions.

3.17 Group Code Recording (GCR). A data encoding method in which a 4-bit group of data bits is encoded into a 5-bit group for recording on magnetic tape (see ANSI X3.54-1986 for more information about this type of recording).

3.18 Load Point (LP) Marker. A single hole punched in the tape to indicate the approaching start of the usable recording area in the forward direction (see Figure 1).

3.19 Nibble. A group of 4 data (5 encoded) bits operated on as a unit.

3.20 Postamble. A special sequence of bits recorded at the end of each recorded block.

3.21 Preamble. A special sequence of bits recorded at the beginning of recorded block.

3.22 Recorded Block. A group of consecutive bits comprising preamble, data block marker, data block, block address, CRC, and postamble.

3.23 Master Standard Amplitude Reference Tape. An amplitude reference tape that has been selected by the National Bureau of Standards (NBS) to establish the reference level for average peak-to-peak signal amplitude output when recorded at 10 000 ftpi (394 ftpmm) on a master measurement system.

3.24 Secondary Standard Amplitude Reference Tape. An amplitude reference tape that has been calibrated by the NBS with respect to the reference level of the master standard amplitude reference tape.³

3.25 Streaming. A method of recording on magnetic tape that maintains continuous tape motion without the requirement to start and stop within an inter-record gap.

3.26 Track. A longitudinal area on the tape along which a series of magnetic signals may be recorded.

3.27 Underrun. A condition that develops when the host transmits or receives data at a rate less than that required by the device for streaming operation.

4. Recording

4.1 Method. The method of recording shall be the "non-return to zero, change on one" (NRZ1) where a ONE is represented by a flux transition occurring in the bit cell and a ZERO is represented by the absence of a flux transition in the bit cell.

4.2 Code. Each 8-bit data byte is separated into two 4-bit groups (nibbles). Each 4-bit data nibble is encoded into a 5-bit GCR nibble for recording on the streaming magnetic tape cartridge. The most significant nibble is recorded first. The encoded data has the property that no more than two consecutive ZEROs shall occur. The translation table for data nibbles (B3, B2, B1, B0) and GCR nibbles (G4, G3, G2, G1, G0) shall be as shown in Table 1.

4.2.1 Byte and Code Requirements

4.2.1.1 Byte Length. The data shall be in 8-bit bytes.

4.2.1.2 Code. Bits b_1 through b_7 shall correspond to the bit assignments for 7-bit ASCII characters as described in ANSI X3.4-1986. Bit b_8 shall always be ZERO when the seven bits, b_1 through b_7 , represent a 7-bit ASCII character.

Each of the bits b_1 through b_8 may be either a ZERO or a ONE when the representation is coded in accordance with a standard, as agreed upon by the interchange parties, which permits such encoding.

4.3 Density of Recording

4.3.1 Density. The nominal recording density shall be 10 000 ftpi (394 ftpmm).

4.3.2 Bit Cell Length. The nominal bit cell length shall be 100 microinches (2.54 micrometers).

4.3.3 Average Bit Cell Length. The average bit cell length is the sum of distances over N bit cells divided by N .

4.3.4 Long-Term Average Bit Cell Length. The long-term average bit cell length is the average bit cell length taken over a minimum of 900 000 bit cells. The long-term average bit cell length shall be within $\pm 4\%$ of the nominal bit cell length.

4.3.5 Short-Term Average Bit Cell Length. The short-term average bit cell length is the average taken over a minimum of 126 and a maximum of 130 bit cells. The short-term average bit cell length shall be within $\pm 7\%$ of the long-term average.

³ A master standard amplitude reference tape has been established at the NBS. Secondary standard amplitude reference tapes are available from NBS under part number SRM 3217. For ordering information, contact: Office of Standard Reference Materials, Room B311, Chemistry Building, National Bureau of Standards, Gaithersburg, MD 20899.

Table 1
Translation Table for Data Nibbles
and GCR Nibbles

HEX	B3	B2	B1	B0		G4	G3	G2	G1	G0	HEX
0	0	0	0	0	↔	1	1	0	0	1	19
1	0	0	0	1	↔	1	1	0	1	1	1B
2	0	0	1	0	↔	1	0	0	1	0	12
3	0	0	1	1	↔	1	0	0	1	1	13
4	0	1	0	0	↔	1	1	1	0	1	1D
5	0	1	0	1	↔	1	0	1	0	1	15
6	0	1	1	0	↔	1	0	1	1	0	16
7	0	1	1	1	↔	1	0	1	1	1	17
8	1	0	0	0	↔	1	1	0	1	0	1A
9	1	0	0	1	↔	0	1	0	0	1	09
A	1	0	1	0	↔	0	1	0	1	0	0A
B	1	0	1	1	↔	0	1	0	1	1	0B
C	1	1	0	0	↔	1	1	1	1	0	1E
D	1	1	0	1	↔	0	1	1	0	1	0D
E	1	1	1	0	↔	0	1	1	1	0	0E
F	1	1	1	1	↔	0	1	1	1	1	0F

NOTE: GCR bit G4 is recorded first.

4.3.6 Rate of Change of Bit Cell Length. The rate of change of bit cell length shall not exceed 0.26%. The rate of change is given by the following relationship.

$$\text{Rate of change} = \frac{|t_1/4 - t_2/4|}{t_3/5}$$

Where t_1 , t_2 , and t_3 are the times between flux transitions as shown in Figure 3. Periods 1 through 5 are contiguous and represent the repetitive data pattern 101010 within a data block, and frequency variations are less than 20 kHz.

4.3.7 Instantaneous Flux Transition Spacing. The instantaneous spacing between flux transitions is influenced by the reading and writing processes, the pattern recorded (pulse-crowding effect) and other factors.

Instantaneous spacings between flux transitions shall satisfy the following conditions.

In a sequence of flux transitions defined by the bit pattern 11100111 (e.g., as occurs in the block marker as described in 5.2), the center flux transition of each group of ONEs is called a reference flux transition. The maximum displacement of flux transitions on either side of the reference flux transitions shall not exceed $\pm 35\%$ of the bit cell length d_1 averaged over the five bit cells between the reference flux transitions indicated in the bit pattern in Figure 4.

4.4 Measurement of Signal Amplitude. The signal in which amplitude shall be measured at a point in the read channel in which the signal is proportional to the rate of change of flux induced in the read head.

4.5 Signal Amplitude

4.5.1 Average Signal Amplitude. When recorded at the physical recording density of 10 000 ftpi (394 ftpmm), the average peak-to-peak signal amplitude output of the interchange tape shall deviate no more than +50%, -35% from the standard reference amplitude. This averaging shall be made over the central 100 flux transitions of any 120 contiguous flux transitions in a block and over at least 100 blocks.

4.5.2 Maximum Signal Amplitude. The peak-to-peak signal amplitude at 3333 ftpi (131 ftpmm) shall be less than three times the standard reference amplitude at 10 000 ftpi (394 ftpmm).

4.5.3 Minimum Signal Amplitude. All transitions on the tape that are intended for data interchange shall have a peak-to-peak signal amplitude greater than or equal to 25% of the standard reference amplitude.

4.6 Erasure. The magnetic tape cartridge shall be ac-erased prior to recording so that base-to-peak signal amplitude is less than 3% of half the standard reference amplitude. When the tape cartridge is recorded, erasure shall be tested between the end of the recorded data and EOT.

4.7 Azimuth. On any track the angle that a flux transition across the track makes with a line perpendicular to reference plane B shall not exceed 9.0 minutes (2.62 mrad).

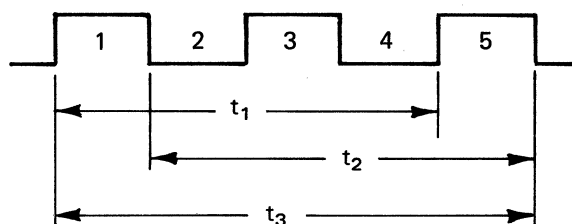
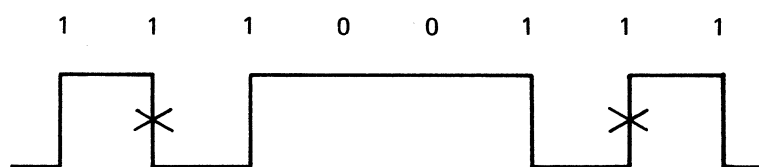


Figure 3
Flux Transition Timing



NOTE: X denotes a reference flux transition.

Figure 4
Bit Pattern

5. Tracks

5.1 Number of Tracks. There shall be a maximum of nine tracks numbered 0 through 8 as specified in 5.4. In the 4-track format, only tracks 0, 1, 2, and 3 are usable. In the 9-track format, all tracks are usable.

5.2 Use of Tracks. Tracks shall be recorded in the numerical order of their track numbers, starting with track 0. Track 0, 2, 4, 6, and 8 shall be recorded in the direction from the BOT marker to the EOT marker. Tracks 1, 3, 5, and 7 shall be recorded in the direction from the EOT marker to the BOT marker.

5.2.1 Track Reference Burst (see Figure 1). A track reference burst recorded at the maximum recording density of 10 000 ftpi (394 ftpmm) shall be written between the BOT marker and the recorded data on track 0. The reference burst shall start a minimum of 0 inches (0 mm) and a maximum of 15 inches (381 mm) from the BOT marker and shall extend past the LP marker for a minimum of 3 inches (76.2 mm) and a maximum of 4 inches (101.6 mm). A long preamble shall precede the first data block.

5.2.2 Even Tracks (see Figure 1). On tracks 0, 2, 4, 6, and 8, data shall commence at a minimum of 3 inches (76.2 mm) and at a maximum of 4 inches (101.6 mm) past the LP marker. No data for interchange shall be recorded beyond 36 inches (914.4 mm) past the EW marker.

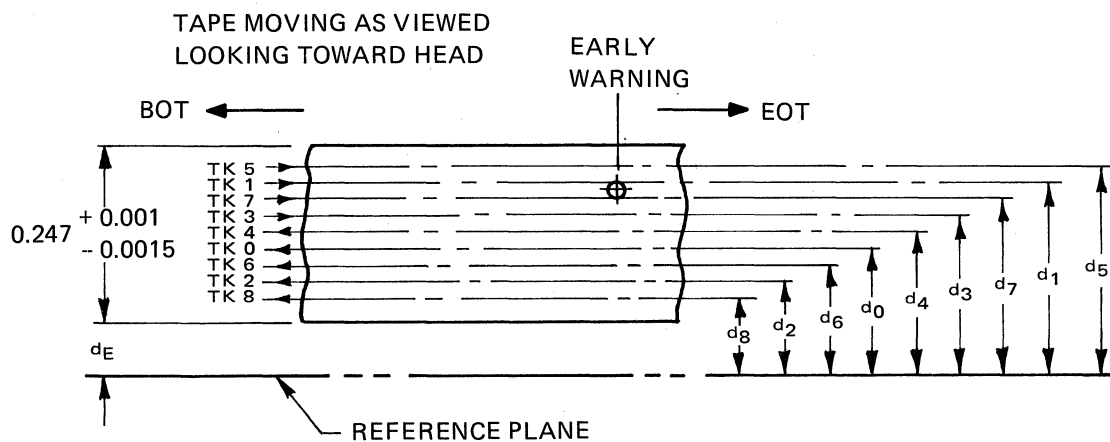
5.2.3 Odd Tracks (see Figure 1). On tracks 1, 3, 5, and 7, data shall commence at a minimum of 1 inch (25.4 mm) and at a maximum of 2 inches (50.8 mm) past the EW marker.

On tracks 1 and 7, the last data or file mark block written shall end at most 4 inches (101.6 mm) and at least 0.1 inches (2.54 mm) before the LP marker, measured from the center of the hole.

If control blocks are used at the end of tracks (see 8.2.2(2)), they shall be recorded starting at least 0.1 inch (2.54 mm) after the LP marker on tracks 1 and 7. A long preamble shall be recorded between the last data (or file mark) block and the control block.

On tracks 3 and 5, the last block written shall end at a maximum of 27 inches (686 mm) past the LP marker.

5.3 Reference Plane. Reference plane B of the magnetic tape cartridge base is the datum for track location.



Dimensions	Inches	Millimeters
d_0	0.172 ± 0.0042	4.369 ± 0.107
d_1	0.268 ± 0.0042	6.807 ± 0.107
d_2	0.124 ± 0.0042	3.150 ± 0.107
d_3	0.220 ± 0.0042	5.588 ± 0.107
d_4	0.196 ± 0.0042	4.978 ± 0.107
d_5	0.292 ± 0.0042	7.417 ± 0.107
d_6	0.148 ± 0.0042	3.759 ± 0.107
d_7	0.244 ± 0.0042	6.198 ± 0.107
d_8	0.100 ± 0.0042	2.540 ± 0.107
d_E (reference)	0.070	1.778

Figure 5
Position of Track Centerlines

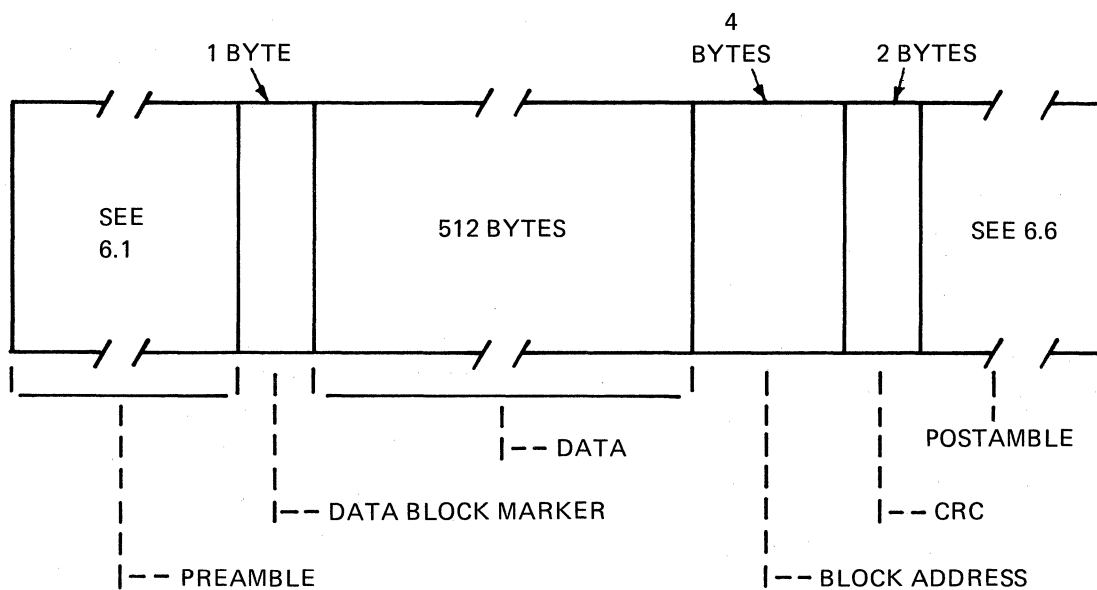
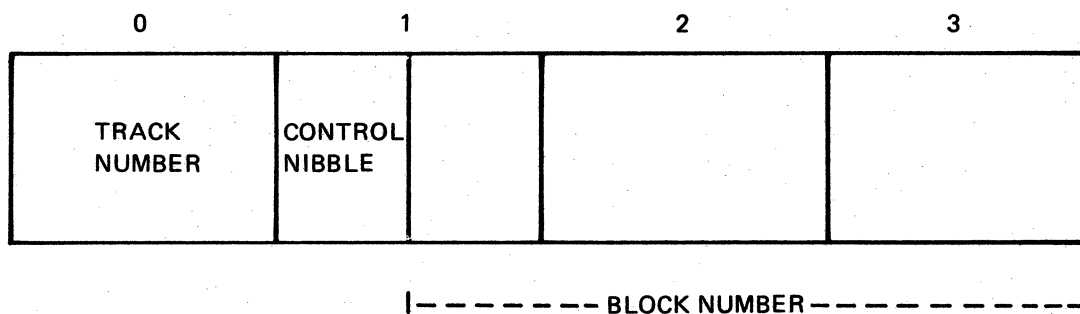


Figure 6
Recorded Block Format



Byte	Bits	Function	Byte	Bits	Function
0	7	Track Number bit 7 (MSB)	2	7	Block Number bit 15
	6	Track Number bit 6		6	Block Number bit 14
	5	Track Number bit 5		5	Block Number bit 13
	4	Track Number bit 4		4	Block Number bit 12
	3	Track Number bit 3		3	Block Number bit 11
	2	Track Number bit 2		2	Block Number bit 10
	1	Track Number bit 1		1	Block Number bit 9
	0	Track Number bit 0 (LSB)		0	Block Number bit 8
1	7	Control Nibble bit 3 (MSB)	3	7	Block Number bit 7
	6	Control Nibble bit 2		6	Block Number bit 6
	5	Control Nibble bit 1		5	Block Number bit 5
	4	Control Nibble bit 0 (LSB)		4	Block Number bit 4
	3	Block Number bit 19 (MSB)		3	Block Number bit 3
	2	Block Number bit 18		2	Block Number bit 2
	1	Block Number bit 17		1	Block Number bit 1
	0	Block Number bit 16		0	Block Number bit 0 (LSB)

NOTE: MSB = Most Significant Bit; LSB = Least Significant Bit.

Figure 7
Block Address

5.4 Track Centerline Locations. Track centerlines shall be located as indicated in Figure 5.

5.5 Track Width. The width of the recorded track shall be 0.036 inch $\pm$ 0.001 inch (0.914 mm $\pm$ 0.025 mm) for the 4-track format and 0.0135 inch $\pm$ 0.0005 inch (0.343 mm $\pm$ 0.013 mm) for the 9-track format.

6. Recorded Block (see Figure 6)

6.1 Preamble

6.1.1 Normal. A normal preamble shall contain a minimum of 120 and a maximum of 300 flux transitions recorded at the maximum normal recording density of 10 000 ftpi (394 ftpmm). The preamble shall be used to synchronize the phase-locked loop in the read electronics to the data frequency. The preamble shall also be used to measure the average signal amplitude.

6.1.2 Elongated. An elongated preamble shall contain a minimum of 3500 and a maximum of 7000 flux transitions and shall precede the first data block recorded after an underrun (see 9.2).

6.1.3 Long. A long preamble shall contain a minimum of 15 000 and a maximum of 30 000 flux transitions and shall precede the first data block for interchange recorded at the beginning of a track.

6.2 Data Block Marker. The data block marker identifies the start of data and shall consist of the following GCR pattern:

G4	G3	G2	G1	G0		G4	G3	G2	G1	G0
1	1	1	1	1		0	0	1	1	1
MS nibble						LS nibble				

6.3 Data Block. The data block shall contain 512 bytes of data for interchange encoded into GCR bytes in accordance with the code (see 4.2).

6.4 Block Address. The block address shall consist of 4 bytes, which uniquely identify a block recorded on tape. The block address shall be encoded into GCR bytes in accordance with the code (see 4.2), and is defined in Figure 7.

6.4.1 Track Number. The track number as specified in Figure 7 shall be recorded in byte 0.

6.4.2 Control Nibble. The definition of control nibble shall be as follows:

3210	Value	Meaning
0000	0	The current block contains user data or file mark.
0001	1	The current block contains control information.
0010–1111	2–15	Reserved.

6.4.3 Block Number. The first block on the tape shall be block 1, and subsequent blocks shall be numbered sequentially. The block number shall not reset at the end of a track.

6.5 Cyclical Redundancy Check. The cyclical redundancy check (CRC) shall consist of two bytes, calculated over the 512 bytes of interchange data, and the 4-byte block address, starting with all ONEs, CRC initial value, and using the CRC generating polynomial:

$$X^{16} + X^{12} + X^5 + 1.$$

The CRC shall be encoded into GCR bytes in accordance with the code (see 4.2).

6.6 Postamble

6.6.1 Normal. A normal postamble, with a minimum of 5 and a maximum of 20 flux transitions, recorded at the maximum nominal flux density, shall be recorded following the CRC as a guardband.

6.6.2 Elongated. An elongated postamble, with a minimum of 3500 and a maximum of 7000 flux transitions, recorded at the maximum nominal flux density, shall be recorded following an underrun sequence.

7. File Mark Block

The file mark block format shall be identical to the data block format except that the data field shall contain 512 bytes consisting of the following GCR pattern:

G4	G3	G2	G1	G0		G4	G3	G2	G1	G0
0	0	1	0	1		0	0	1	0	1
MS nibble						LS nibble				

The GCR nibble 00101 shall be converted to the data nibble 1111 to form the data field for CRC generation and checking.

The postamble of a file mark block shall always be an elongated postamble. A file mark may be recorded between blocks anywhere on the tape. The last block of an interchange tape shall be a file mark. It may be omitted if data blocks are recorded on track 3 beyond the LP marker in the 4-track format or on track 8 beyond the EW marker in the 9-track format.

8. Control Block

8.1 Data Field. When the control nibble value equals 1, the current 512-byte data field contains control information. This control information is defined as follows:

Byte	Meaning
0 (MS)	Drive Type: 04H = 4 track device. 09H = 9 track device.
1	Type of Control Block 00H = dummy. 01H = first block on a track. 02H = last block on a track. 03H = extended file marks. 04–1FH = Reserved 20–FFH = Not defined.
2	File Mark Number (MSB).
3	File Mark Number (LSB).
4–0F 10–1FF	Reserved (Set to 00H). Not defined in this standard.

8.2 Use of Control Blocks. The use of control blocks is optional. A tape containing control blocks as specified in 8.1 shall be acceptable for interchange. The recipient of the cartridge shall read the whole contents of each control block in order to check the CRC and to maintain the sequence of block numbers, but may ignore the data field. If control blocks are included, the following rules apply.

8.2.1 Track 0. On Track 0 the first block shall be a control block with the first byte of the data field set to 04H for the 4-track format and 09H for the 9-track format. The remaining bytes are used as defined in 8.1.

8.2.2 Further Uses of Control Blocks. Control blocks may be used in one or more of the following three cases:

- (1) A control block shall be written as the first block on each track.
- (2) A control block shall be written as the last block on each track, provided that the writing is continued on the following track. In this case, the contents of the second byte of the data field depends on whether the preceding (last) data (or file mark) block was verified as good or bad.

If the last data (or file mark) block was verified as good, the second byte of the data field shall be set to 02H.

If the last data (or file mark) block was verified as bad, the second byte of the data field shall be set to 00H.

To allow time to verify the last block, an elongated preamble shall be recorded prior to writing the control block on all tracks except on tracks 1 and 7.

On tracks 1 and 7, a long preamble shall be recorded prior to writing the control block in such a way that

the control block marker is located at least 0.1 inches (2.54 mm) after the LP marker.

(3) A control block shall precede each file mark block. The second byte of the data field shall be set to 03H.

In this case, file mark blocks are numbered from 0 to 65 535 by using the third and fourth bytes of the data field in the control block as specified in 8.1. This is in addition to their block number specified in 6.4.3.

9. Rewritten Blocks

9.1 Error. When recording on tape, some blocks may have to be rewritten further down the tape. This is done to improve the system error rate. The decision criteria for the rewrite operation are not part of this standard, except as specified in 4.5.3.

A block N may be recognized as erroneous before or after block $N + 1$ has been partly or completely written but it shall always be so recognized before the writing of block $N + 2$ commences.

An erroneous block shall not be erased; it shall be rewritten further down tape.

A correct block N shall be followed, not necessarily immediately, by a correct block $N + 1$.

An erroneous block shall not be rewritten more than 16 times.

Rewritten blocks shall retain their block number. In addition, if applicable, file mark blocks shall retain their file mark block number.

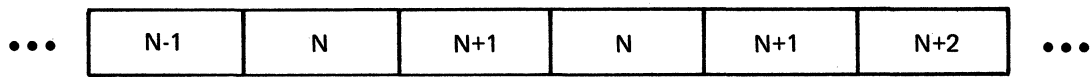
Various sequences of rewritten blocks are shown in Figure 8.

9.2 Streaming Termination. Streaming operation shall be terminated when an end of track condition exists, and may be terminated when underrun or end of file conditions exist. The normal sequence of recording of blocks N , $N + 1$, and so on shall be replaced by the repeated sequence of block N until the recording of block N meets the requirements for interchange. When block N is recorded such that the requirements of interchange are met, the associated rewriting of block N is completed or truncated. An elongated postamble (see 6.6.2) shall be written as shown in Figure 9(a).

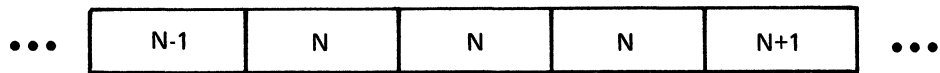
Recording of the elongated preamble (see 6.1.2) following the elongated postamble shall begin at 3000 flux transitions minimum, 3500 flux transitions maximum from the end of the block preceding the elongated postamble, as shown in Figure 9(b). An elongated preamble shall be recorded before recording any other field in the block.

9.3 Forced Streaming. Termination of streaming operation due to underrun may be prevented by continued recording of the last block until end of file or end of track occurs. Standard length format fields shall be used during forced streaming operation (see Figure 10).

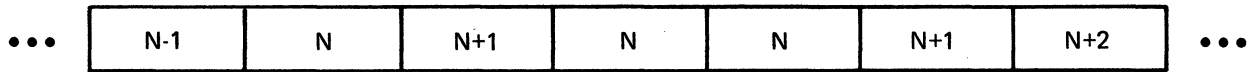
9.4 End of Recorded Data. The end of recorded data shall be indicated by a file mark block followed by at least 45 inches (1140 mm) of erased track. If the end of the permissible recording area of the track is reached before this distance is passed, the measurement shall be continued on the next track, unless this track was the last track.



(a)

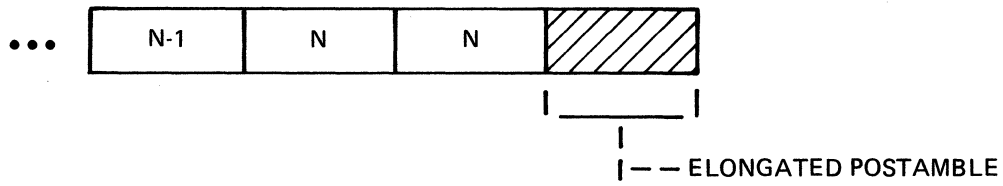


(b)

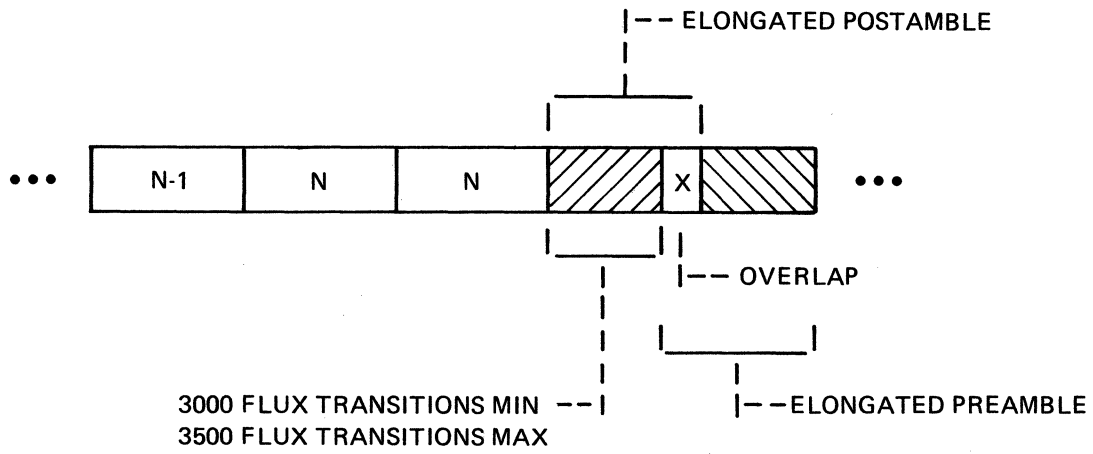


(c)

Figure 8
Sequences of Rewritten Blocks



(a) Writing an Elongated Preamble



(b) Recording an Elongated Preamble

Figure 9
Streaming Termination

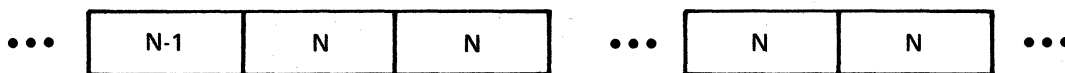


Figure 10
Forced Streaming

X3.115-1984 Unformatted 80 Megabyte Trident Pack for Use at 370 tpi and 6000 bpi (General, Physical, and Magnetic Characteristics)

X3.117-1984 Printable/Image Areas for Text and Facsimile Communication Equipment

X3.118-1984 Financial Services — Personal Identification Number — PIN Pad

X3.119-1984 Contact Start/Stop Storage Disk, 158361 Flux Transitions per Track, 8.268 Inch (210 mm) Outer Diameter and 3.937 inch (100 mm) Inner Diameter

X3.120-1984 Contact Start/Stop Storage Disk

X3.121-1984 Two-Sided, Unformatted, 8-Inch (200-mm), 48-tpi, Double-Density, Flexible Disk Cartridge for 13 262 ftpr Two-Headed Application

X3.124-1985 Graphical Kernel System (GKS) Functional Description

X3.124.1-1985 Graphical Kernel System (GKS) FORTRAN Binding

X3.125-1985 Two-Sided, Double-Density, Unformatted 5.25-inch (130-mm), 48-tpi (1,9-tpmm), Flexible Disk Cartridge for 7958 bpr Use

X3.126-1986 One- or Two-Sided Double-Density Unformatted 5.25-inch (130-mm), 96 Tracks per Inch, Flexible Disk Cartridge

X3.128-1986 Contact Start-Stop Storage Disk — 83 000 Flux Transitions per Track, 130-mm (5.118-in) Outer Diameter and 40-mm (1.575-in) Inner Diameter.

X3.129-1986 Intelligent Peripheral Interface, Physical Level

X3.130-1986 Intelligent Peripheral Interface, Logical Device Specific Command Sets for Magnetic Disk Drive

X3.136-1986 Serial Recorded Magnetic Tape Cartridge for Information Interchange, Four and Nine Track

X3.140-1986 Open Systems Interconnection — Connection Oriented Transport Layer Protocol Specification

X11.1-1977 Programming Language MUMPS

IEEE 416-1978 Abbreviated Test Language for All Systems (ATLAS)

IEEE 716-1982 Standard C/ATLAS Language

IEEE 717-1982 Standard C/ATLAS Syntax

IEEE 770X3.97-1983 Programming Language PASCAL

IEEE 771-1980 Guide to the Use of ATLAS

ISO 8211-1986 Specifications for a Data Descriptive File for Information Interchange

MIL-STD-1815A-1983 Reference Manual for the Ada Programming Language

X3/TRI-82 Dictionary for Information Processing Systems (Technical Report)

American National Standards for Information Processing

- X3.1-1976** Synchronous Signaling Rates for Data Transmission
- X3.2-1970** Print Specifications for Magnetic Ink Character Recognition
- X3.4-1986** Coded Character Sets — 7-Bit ASCII
- X3.5-1970** Flowchart Symbols and Their Usage
- X3.6-1965** Perforated Tape Code
- X3.9-1978** Programming Language FORTRAN
- X3.11-1969** General Purpose Paper Cards
- X3.14-1983** Recorded Magnetic Tape (200 CPI, NRZI)
- X3.15-1976** Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission
- X3.16-1976** Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
- X3.17-1981** Character Set for Optical Character Recognition (OCR-A)
- X3.18-1974** One-Inch Perforated Paper Tape
- X3.19-1974** Eleven-Sixteenths-Inch Perforated Paper Tape
- X3.20-1967** Take-Up Reels for One-Inch Perforated Tape
- X3.21-1967** Rectangular Holes in Twelve-Row Punched Cards
- X3.22-1983** Recorded Magnetic Tape (800 CPI, NRZI)
- X3.23-1985** Programming Language COBOL
- X3.25-1976** Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the American National Standard Code for Information Interchange
- X3.26-1980** Hollerith Punched Card Code
- X3.27-1978** Magnetic Tape Labels and File Structure
- X3.28-1976** Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
- X3.29-1971** Specifications for Properties of Unpunched Oiled Paper Perforator Tape
- X3.30-1971** Representation for Calendar Date and Ordinal Date
- X3.31-1973** Structure for the Identification of the Counties of the United States
- X3.32-1973** Graphic Representation of the Control Characters of American National Standard Code for Information Interchange
- X3.34-1972** Interchange Rolls of Perforated Tape
- X3.36-1975** Synchronous High-Speed Data Signaling Rates between Data Terminal Equipment and Data Communication Equipment
- X3.37-1980** Programming Language APT
- X3.38-1972** Identification of States of the United States (Including the District of Columbia)
- X3.39-1986** Recorded Magnetic Tape (1600 CPI, PE)
- X3.40-1983** Unrecorded Magnetic Tape (9-Track 800 CPI, NRZI; 1600 CPI, PE; and 6250 CPI, GCR)
- X3.41-1974** Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange
- X3.42-1975** Representation of Numeric Values in Character Strings
- X3.43-1977** Representations of Local Time of the Day
- X3.44-1974** Determination of the Performance of Data Communication Systems
- X3.45-1982** Character Set for Handprinting
- X3.46-1974** Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)
- X3.47-1977** Structure for the Identification of Named Populated Places and Related Entities of the States of the United States for Information Interchange
- X3.48-1986** Magnetic Tape Cassettes (3.81-mm [0.150-Inch] Tape at 32 bps [800 bpi], PE)
- X3.49-1975** Character Set for Optical Character Recognition (OCR-B)
- X3.50-1976** Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets
- X3.51-1975** Representations of Universal Time, Local Time Differentials, and United States Time Zone References
- X3.52-1976** Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI) (General, Physical, and Magnetic Requirements)
- X3.53-1976** Programming Language PL/I
- X3.54-1986** Recorded Magnetic Tape (6250 CPI, Group Coded Recording)
- X3.55-1982** Unrecorded Magnetic Tape Cartridge, 0.250 Inch (6.30 mm), 1600 bpi (63 bps), Phase encoded
- X3.56-1986** Recorded Magnetic Tape Cartridge, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bps), Phase Encoded
- X3.57-1977** Structure for Formatting Message Headings Using the American National Standard Code for Information Interchange for Data Communication Systems Control
- X3.58-1977** Unrecorded Eleven-Disk Pack (General, Physical, and Magnetic Requirements)
- X3.59-1981** Magnetic Tape Cassettes, Dual Track Complementary Return-to-Bias (CRB) Four-States Recording on 3.81-mm (0.150-Inch) Tape
- X3.60-1978** Programming Language Minimal BASIC
- X3.61-1978** Representation of Geographic Point Locations
- X3.62-1979** Paper Used in Optical Character Recognition (OCR) Systems
- X3.63-1981** Unrecorded Twelve-Disk Pack (100 Megabytes) (General, Physical, and Magnetic Requirements)
- X3.64-1979** Additional Controls for Use with American National Standard Code for Information Interchange
- X3.66-1979** Advanced Data Communication Control Procedures (ADCCP)
- X3.72-1981** Parallel Recorded Magnetic Tape Cartridge, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bps), Phase Encoded
- X3.73-1980** Single-Sided Unformatted Flexible Disk Cartridge (for 6631-BPR Use)
- X3.74-1981** Programming Language PL/I, General-Purpose Subset
- X3.76-1981** Unformatted Single-Disk Cartridge (Top Loading, 200 tpi 4400 bpi) (General, Physical, and Magnetic Requirements)
- X3.77-1980** Representation of Pocket Select Characters
- X3.78-1981** Representation of Vertical Carriage Positioning Characters in Information Interchange
- X3.79-1981** Determination of Performance of Data Communications Systems That Use Bit-Oriented Communication Procedures
- X3.80-1981** Interfaces between Flexible Disk Cartridge Drives and Their Host Controllers
- X3.82-1980** One-Sided Single-Density Unformatted 5.25-Inch Flexible Disk Cartridge (for 3979-BPR Use)
- X3.83-1980** ANSI Sponsorship Procedures for ISO Registration According to ISO 2375
- X3.84-1981** Unformatted Twelve-Disk Pack (200 Megabytes) (General, Physical, and Magnetic Requirements)
- X3.85-1981** 1/2-Inch Magnetic Tape Interchange Using a Self Loading Cartridge
- X3.86-1980** Optical Character Recognition (OCR) Inks
- X3.88-1981** Computer Program Abstracts
- X3.89-1981** Unrecorded Single-Disk, Double-Density Cartridge (Front Loading, 2200 bpi, 200 tpi) (General, Physical, and Magnetic Requirements)
- X3.91M-1982** Storage Module Interfaces
- X3.92-1981** Data Encryption Algorithm
- X3.93M-1981** OCR Character Positioning
- X3.94-1985** Programming Language PASCAL
- X3.95-1982** Microprocessors — Hexadecimal Input/Output, Using 5-Bit and 7-Bit Teleprinters
- X3.96-1983** Continuous Business Forms (Single-Part)
- X3.98-1983** Text Information Interchange in Page Image Format (PIF)
- X3.99-1983** Print Quality Guideline for Optical Character Recognition (OCR)
- X3.100-1983** Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Packet Mode Operation with Packet Switched Data Communications Network
- X3.101-1984** Interfaces Between Rigid Disk Drive(s) and Host(s)
- X3.102-1983** Data Communication Systems and Services — User-Oriented Performance Parameters
- X3.103-1983** Unrecorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in)
- X3.104-1983** Recorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in), Phase Encoded
- X3.105-1983** Data Link Encryption
- X3.106-1983** Modes of Operation for the Data Encryption Algorithm
- X3.110-1983** Videotex/Teletext Presentation Level Protocol Syntax
- X3.111-1986** Optical Character Recognition (OCR) Matrix Character Sets for OCR-M
- X3.112-1984** 14-in (356-mm) Diameter Low-Surface-Friction Magnetic Storage Disk
- X3.114-1984** Alphanumeric Machines; Coded Character Sets for Keyboard Arrangements in ANSI X4.23-1982 and X4.22-1983

(continued on reverse)